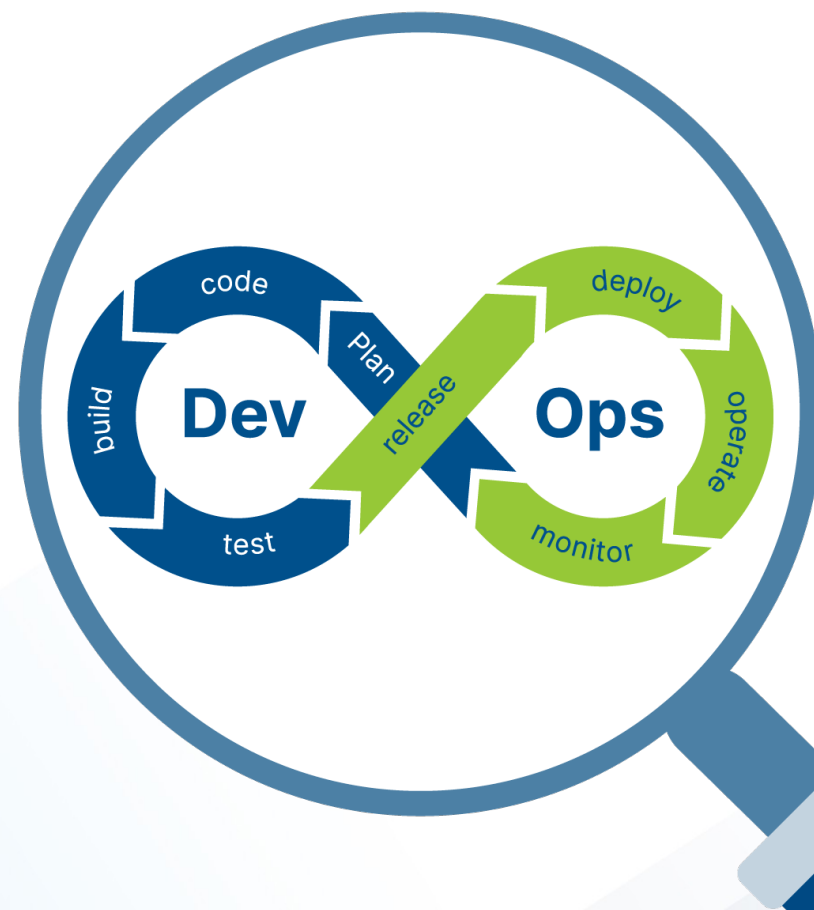# Automated Testing and Continuous Integration/Delivery: Lessons Learned

Presented by
Toradex

WITH YOU TODAY...

- Joined Toradex 2011

- Spearheaded Embedded Linux Adoption

- Introduced Upstream First Policy

- Top 10 U-Boot Contributor

- Top 10 Linux Kernel Arm SoC Contributor

- Industrial Embedded Linux Platform Torizon Fully Based on Mainline Technology

  - Mainline U-Boot with Distroboot

  - KMS/DRM Graphics with Etnaviv & Nouveau

  - OTA with OSTree

  - Docker resp. Podman

Marcel Ziswiler

Software Team Lead - Embedded Linux BSP

Toradex

WE'RE LOCATED IN LUCERNE, SWITZERLAND

WHAT WE'LL COVER TODAY…

- What is the goal?

- AT, CI/CD landscape

- Lessons learned

- Open discussion

AGENDA

What is the Goal of This Whole AT and CI/CD Stuff?

- Deliver more often and better-tested software

- Catch regressions

- Manual testing very cumbersome

- Submitting sub-par patches on mailing lists annoys everybody

How Does our AT and CI/CD Landscape Look Like

- Source code management (SCM): GitLab

- Build infrastructure: Jenkins

- DevOps artifact/binary storage: JFrog Artifactory

- Automated testing: LAVA board farm

- Linked to further infrastructure

  - Confluence/Jira

  - Email

  - Slack

- So far all running on-premise

  - Board farm anyway needs close "local" attention/monitoring

  - Running hundreds of full Yocto Project builds every night will bear high costs if deployed to commercial cloud
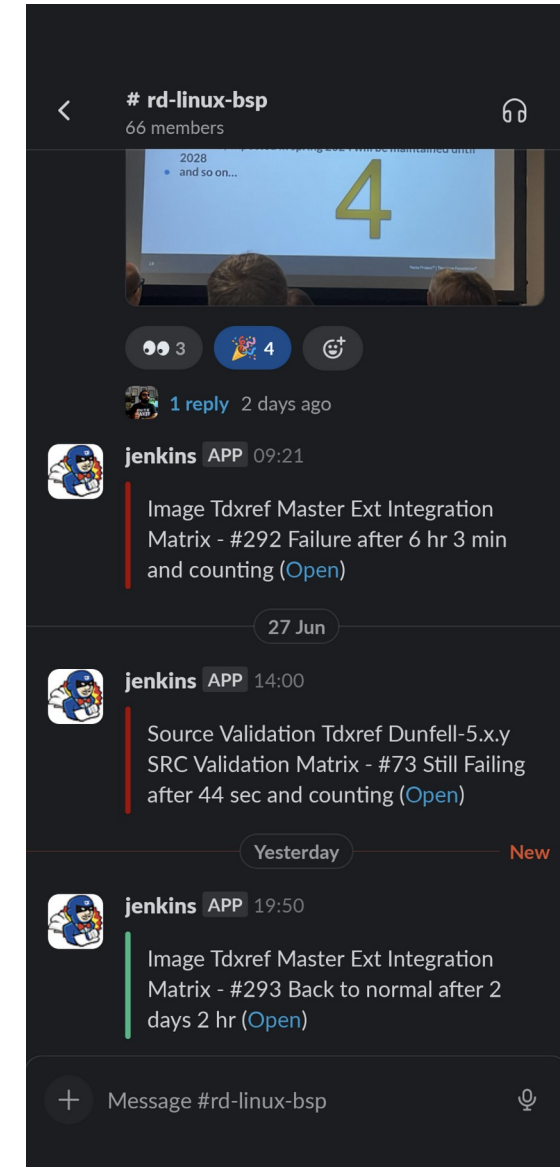
GitLab Source Code Management (SCM)

- Any source code (and configuration) change requires merge request

- Merge requests need at least one reviewer/approver

- Upstream first with internal pre-approval process

- GitLab CI to catch regressions

- Most upstream projects already have some form of AT resp. CI/CD integration available

- Coping with various branches/versions might require quite some integration effort (e.g. different tooling required)

GitLab

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[PATCH v2 0/3] board: tora...

gitlab.int.toradex.com/rd/linux-bsp/u-boot-toradex-next/-/merge_requests/84

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Search GitLab

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U U-Boot Toradex Next

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- Wiki
- Snippets

Research and Development > Linux BSP > U-Boot Toradex Next > Merge requests > !84

[PATCH v2 0/3] board: toradex: add verdin am62 support

Code

Merged   **Marcel Ziswiler** requested to merge `marcel.ziswiler/u-boot-tor...` into `for-next-v2023.10/v2-initi...` 2 weeks ago

Overview 3   Commits 14   Pipelines 1   Changes 37

This series adds initial support for the Toradex Verdin AM62 SoM [1]. The first commit adds resp. PID4 to the ConfigBlock, the second one fixes an early clocking issue confirmed to be a weird bug in TI's scripting. And last but not least support for the Toradex Verdin AM62 is added.

Please note that this series is based on Emanuele's recent work on get_ram_size() [2].

[1] https://www.toradex.com/computer-on-modules/verdin-arm-family/ti-am62 [2] https://lore.kernel.org/all/20230530133327.178278-1-francesco@dolcini.it

Changes in v2:

- Add Bryan's reviewed-by tag. Thanks!
- Use 1.2 GHz rather than 1.25 GHz A53 clock as on the EVM/SK.
- Also add power-domain 166 as on the EVM/SK.
- Get rid of main_bcdma and main_pktdma as not required in R5 SPL.
- Get rid of all bootph-pre-ram in Ethernet and SDHC1 aka SD card related pinctrls as not required in any SPL.
- Enable CONFIG_TI_SECURE_DEVICE by default as Non-HS devices will continue to boot due to runtime device type detection.
- Disable FAT and SPI support as not required in R5 SPL.
- Also enable CONFIG_SPL_MMC_HS200_SUPPORT in R5 SPL.
- Enable CONFIG_LEGACY_IMAGE_FORMAT to allow sourcing unsigned script images e.g. like our current boot scripts.
- Increase CONFIG_SYS_BOOTM_LEN to 64 MB to allow booting bigger compressed images as e.g. in the Toradex Easy Installer case.
- Change memory configurations to operate at temperatures of up to 95 degrees celsius.
- Increase CONFIG_SYS_MAXARGS from default 16 to 64.
- Enable CONFIG_CMD_REMOTEPROC, CONFIG_SPL_DM_GPIO_LOOKUP_LABEL and CONFIG_SPL_I2C_EEPROM.
- For R5 SPL increase CONFIG_SPL_STACK_R_MALLOC_SIMPLE_LEN to 0x140000, enable CONFIG_SPL_I2C, CONFIG_DM_I2C, CONFIG_SYS_I2C_OMAP24XX and savedefconfig got rid of CONFIG_SPL_FIT_IMAGE_POST_PROCESS.

Marcel Ziswiler (3): toradex: tdx-cfg-block: add 0069 verdin am62 quad 1gb wb it arm: mach-k3: am62: fix 2nd mux option of clkout0 board: toradex: add verdin am62 support

arch/arm/dts/Makefile | 3 + arch/arm/dts/k3-am62-verdin-dev.dtsi | 248 ++ arch/arm/dts/k3-am62-verdin-wifi.dtsi | 39 + arch/arm/dts/k3-am62-verdin.dtsi | 1411 +++++++++++++ .../dts/k3-am625-verdin-lpddr4-1600MTs.dtsi | 2190 +++++++++++++++++++ arch/arm/dts/k3-am625-verdin-r5.dts | 115 + .../dts/k3-am625-verdin-wifi-dev-u-boot.dtsi | 215 ++ arch/arm/dts/k3-am625-verdin-wifi-dev.dts | 22 + arch/arm/mach-k3/Kconfig | 1 + arch/arm/mach-k3/am62x/clk-data.c | 5 +- board/toradex/common/tdx-cfg-block.c | 1 + board/toradex/common/tdx-cfg-block.h | 1 + board/toradex/verdin-am62/Kconfig | 80 + board/toradex/verdin-am62/MAINTAINERS | 16 + board/toradex/verdin-am62/Makefile | 6 + board/toradex/verdin-am62/verdin-am62.c | 117 + configs/verdin-am62_a53_defconfig | 184 ++ configs/verdin-am62_r5_defconfig | 111 + doc/board/toradex/verdin-am62.rst | 167 ++ include/configs/verdin-

5 Assignees

- Max Krummenacher
- Francesco Dolcini
- Emanuele Ghidoli
- Andrejs Cainikovs
- Aishwarya Kothari

0 Reviewers
None

Labels
None

Milestone
None

Time tracking
No estimate or time spent

Lock merge request
Unlocked

6 participants

Reference: rd/linux-bsp/u-boot-to...
Source branch: `for-next-v202...`

Collapse sidebar

GitLab

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Pipeline · Research and D...

gitlab.int.toradex.com/rd/linux-bsp/u-boot-toradex-next/-/pipelines/60587

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U-Boot Toradex Next

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- CI/CD
  - **Pipelines**
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- Deployments
- Packages and registries
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- Snippets

8 jobs for !84 with `for-next-v2023.10/v2-initial-verdin-am62-support-usb` in 2 minutes and 10 seconds (queued for 6 seconds)

latest   merge request

9873af44

1 related merge request: !84 [PATCH v2 0/3] board: toradex: add verdin am62 support

Pipeline   Needs   Jobs 8   Failed Jobs 3   Tests 0

Group jobs by   Stage   Job dependencies

testsuites

- ✓ Build envtools
- ⚠ check_patch
- ✓ cppcheck
- ✓ grep TODO/FIXME/HACK
- ✓ sloccount

toradex build

- ✗ 32bit Toradex Boards
- ✗ 64bit Toradex Boards

project ci

- ⚙ proj_pipeline ▶
  - Trigger job

« Collapse sidebar

Jenkins Build Infrastructure

- Build complete Yocto Project images

- From source code to artefacts

- Triggers automated tests

Jenkins

TDX Reference [Jenkins]

jenkins.int.toradex.com

Search (CTRL+K)

Marcel Ziswiler ⌄   log out

Dashboard ›

- People
- Build History
- Project Relationship
- Check File Fingerprint
- My Views
- Open Blue Ocean

Build Queue (2) ⌄

Source Validation Tdxref LinuxImage3.0-next SRC Validation Matrix

Source Validation Tdxref LinuxImageV2.8-integration SRC Validation Matrix

Build Executor Status ⌄

Built-In Node

1 Idle
2 Idle
3 Idle
4 Idle
5 Idle
6 Idle
7 Idle
8 Idle

OE Prune Matrix V2

BSP Layers and Reference Images for Yocto Project && TorizonCore

| All | Build Calendar | Build Monitor | CICD-Testing | Images - Other | Images - Tezi | Images - Torizon | OE Post Actions | SOM FCT and Testing | Seed Jobs |

TDX Reference

S	W	Name ↓	Last Success	Last Failure	Last Duration		Built On	Fav
✓	☀	Image Tdxref Dunfell-5.x.y Ext Integration Matrix	4 days 12 hr #141	N/A	9 hr 21 min	▷	Jenkins	☆
✓	☀	Image Tdxref Dunfell-5.x.y Nightly Matrix	2 days 14 hr #788	N/A	3 hr 22 min	▷	Jenkins	☆
✓	⛅	Image Tdxref Dunfell-5.x.y Release Matrix	4 mo 5 days #21	1 yr 3 mo #17	22 hr	▷	Jenkins	☆
⊗	🌧	Image Tdxref Kirkstone-6.x.y Ext Integration Matrix	25 days #62	4 days 0 hr #65	9 hr 28 min	▷	Jenkins	☆
!	☀	Image Tdxref Kirkstone-6.x.y Monthly Release Matrix	25 days #11	N/A	8 hr 30 min	▷	Jenkins	☆
✓	☀	Image Tdxref Kirkstone-6.x.y Nightly Matrix	15 hr #321	15 days #309	2 hr 56 min	▷	Jenkins	☆
✓	⛅	Image Tdxref Kirkstone-6.x.y Release Matrix	2 mo 25 days #6	5 mo 26 days #2	1 day 0 hr	▷	Jenkins	☆
✓	☀	Image Tdxref LinuxImage4.0 Ext Integration Matrix	2 yr 9 mo #18	N/A	59 min	▷	Jenkins	☆
⊗	🌧	Image Tdxref LinuxImage4.0 Monthly Release Matrix	3 yr 0 mo #4	2 yr 7 mo #7	5 hr 38 min	▷	Jenkins	☆
⊗	🌧	Image Tdxref Master Ext Integration Matrix	8 days 20 hr #291	2 days 8 hr #292	36 min	▷	Jenkins	☆

Jenkins

Artifactory DevOps Storage

- Storage and retrieval of DevOps artifacts/binaries

- Handles everything incl. SBOMs and test reports

Artifactory

Report for extint master tdxref build 291

Overview report for extint master tdxref build number 291.

Jobs for tdx-reference-multimedia-image tdx-xwayland

Overview of all jobs with failures or missing test runs. (Jobs of excluded PID4s are not shown). Find detailed report here.

No failed test jobs found. All fine!

Jobs for tdx-reference-multimedia-image tdx-xwayland-upstream

Overview of all jobs with failures or missing test runs. (Jobs of excluded PID4s are not shown). Find detailed report here.

No failed test jobs found. All fine!

Jobs for tdx-reference-multimedia-image tdx-xwayland-rt

Overview of all jobs with failures or missing test runs. (Jobs of excluded PID4s are not shown). Find detailed report here.

No failed test jobs found. All fine!

Jobs for tdx-reference-multimedia-image tdx-xwayland-upstream-rt

Overview of all jobs with failures or missing test runs. (Jobs of excluded PID4s are not shown). Find detailed report here.

No failed test jobs found. All fine!

Jobs for tdx-reference-minimal-image tdx-xwayland

Overview of all jobs with failures or missing test runs. (Jobs of excluded PID4s are not shown). Find detailed report here.

No failed test jobs found. All fine!

Jobs for tdx-reference-minimal-image tdx-xwayland-upstream

Overview of all jobs with failures or missing test runs. (Jobs of excluded PID4s are not shown). Find detailed report here.

No failed test jobs found. All fine!

Artifactory
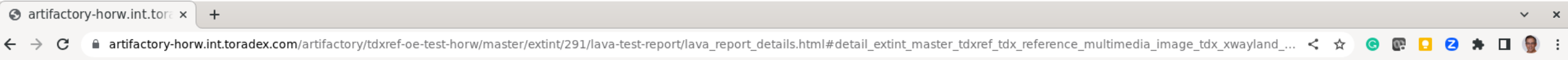
Report for extint master tdxref build 291

Detailed report for jenkins matrix [extint master tdxrefbuild number 291](#)

Details for extint master tdxref tdx-reference-minimal-image tdx-xwayland 291

PID4 ▼	Devicename	Job Health	#Failed Tests	#Not Run	ip_addr_test	ip_link_up_lo_test	ip_route_test	netstat_test	ping_test
0055	Verdin-iMX8M-Mini-Quad-2GB-WiFi-BT-IT	Complete	0	0	☑	☑	☑	☑	☑
0057	Verdin-iMX8M-Mini-DualLite-1GB	Complete	0	0	☑	☑	☑	☑	☑
0059	Verdin-iMX8M-Mini-Quad-2GB-IT	Complete	0	0	☑	☑	☑	☑	☑
0060	Verdin-iMX8M-Mini-DualLite-1GB-WiFi-BT-IT	Complete	0	0	☑	☑	☑	☑	☑
0068	Verdin-iMX8M-Mini-Quad-2GB-WiFi-BT-IT	Complete	0	0	☑	☑	☑	☑	☑

LAVA Automated Testing Board Farm

- Board farm

  - Organised in shelfs

    - Per shelf controller featuring a Cypress USB micro controller taking care of power, recovery mode and reset signals

    - Integrated USB hubs and/or FTDI USB-to-serial adapters

    - Ethernet switch

    - Featuring carrier boards for one family of SoMs

    - Goal: Only one Ethernet, power and USB cable per shelf, otherwise self-contained

    - Also used for validation and verification in temperature chamber

  - Power supplies

  - Accompanying testing infrastructure

    - Every hardware interface with loopback or peer for real-life testing

  - Start in recovery mode, flash entire Yocto Project images, boot the "real" thing
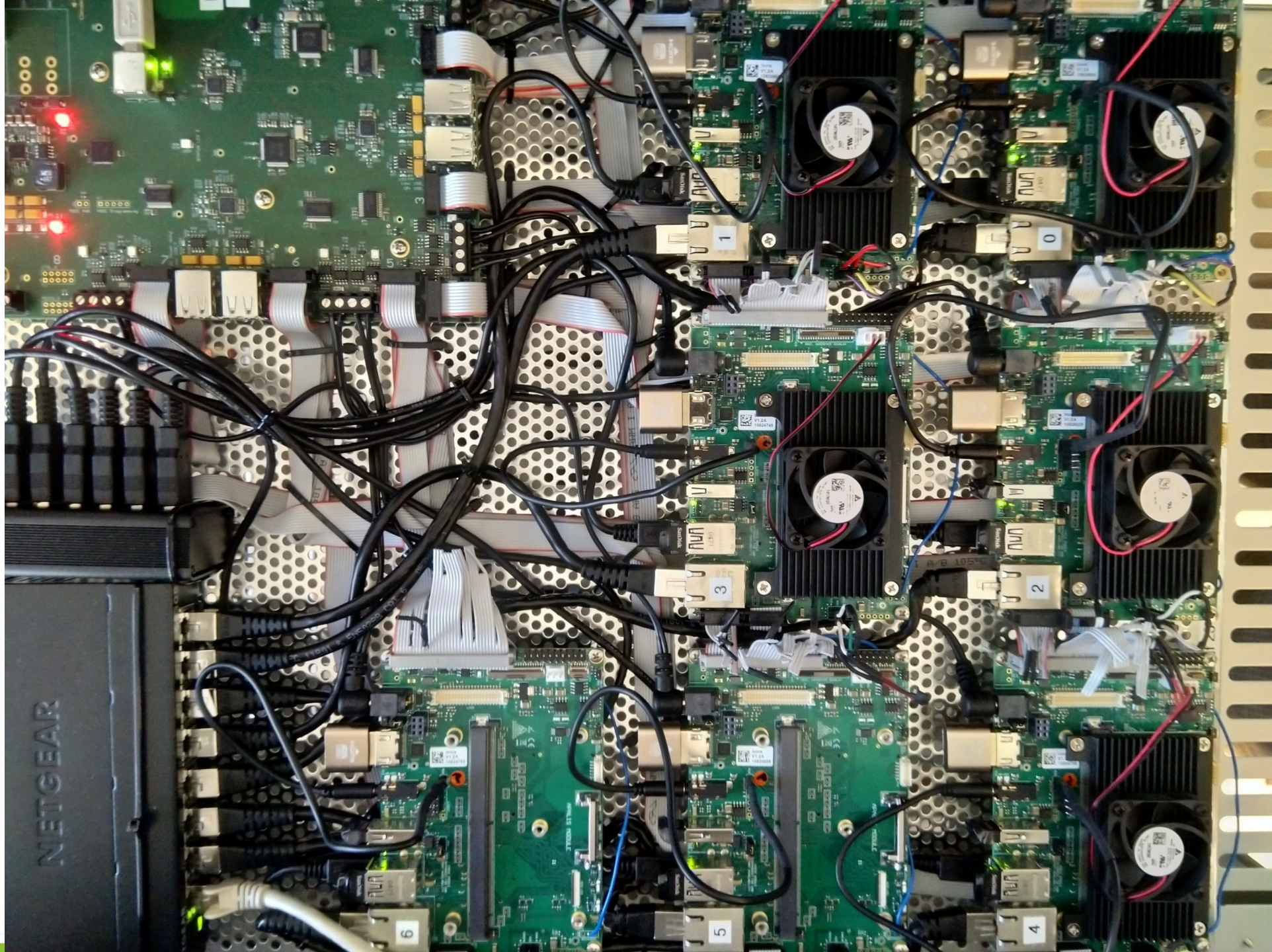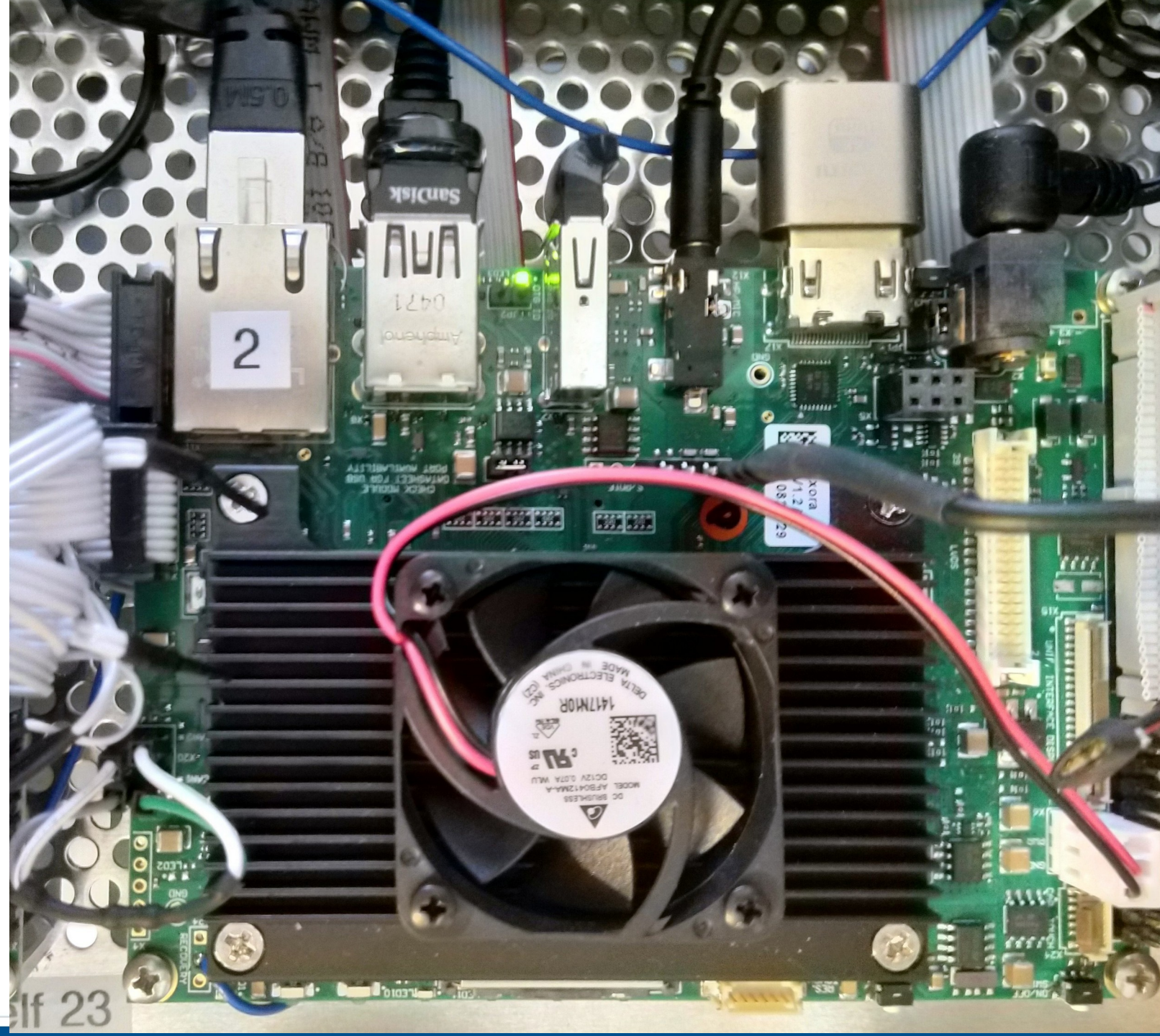
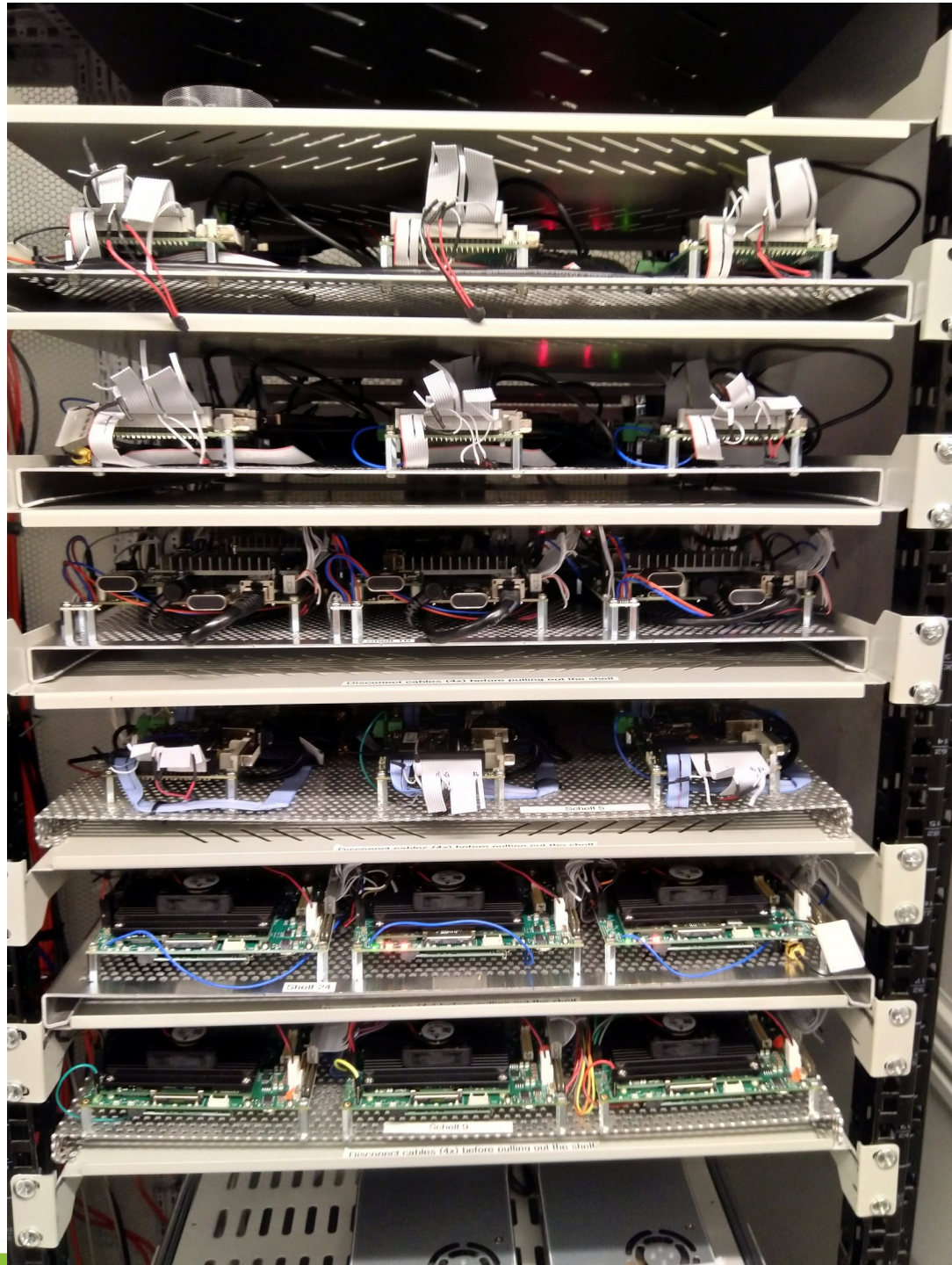# Board Farm

Board Farm

Board Farm

Board Farm

Board Farm

Lessons Learned

- 99% reliability not enough: All processes and infrastructure must be highly reliable
  Sporadic issues with single devices testing, such appearances will scale up with amount and frequency of your tests, stakeholders loose trust in test results and whole infrastructure

- Test infrastructure needs to be resilient: Even if some hardware issues will remain
  Everything that could possible go wrong, will go wrong one day.
  If you can not fix sporadic issues at least make infrastructure resilient to come over such sporadic issues

- Scaling up is not linear: Unexpected things will happen when scaling up
  Single devices working smoothly on your desk will start behaving wired if you scale up.
  E.g. Flashing devices via uuu/USB may work completely fine with one devices. Scaling up we saw crashes of the whole USB stack (root hub got broken). Getting things robust takes a lot of time and effort.

- Manage infrastructure as code: Manage your device fleet in code.
  Using Ansible to provision our infrastructure and manage devices running in Lava makes your setup very reproducible and documentation is also done by design.

- Test infrastructure is teamwork: Infrastructure can not be outsourced to a "Testing Team"
  Software and infrastructure teams have to collaborate tightly or even be one combined team for a while.

- Test infrastructure is a process not a project: Test infrastructure is like an organism that grows and changes
  It needs love over time and processes and setup needs to be adapted to requirements over time.

References

- GitLab
  https://about.gitlab.com

- Jenkins
  https://www.jenkins.io

- Artifactory
  https://jfrog.com/artifactory

- LAVA
  https://validation.linaro.org

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